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GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, M.D., D.Sc. (CANTAB.), LL.D., F.R.S.

MINERAL RESOURCES OF CANADA

MANGANESE

Reprint of Article in Annual Report of Section of Mines for 1902, Part S, Vol. XV.

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GEOLOGICAL SURVEY OF CANANA, OTTAWA.

To Dr. ROBERT BELL, L.L.D., F.R.S., &c.,
Acting Director.

SIR:—The following pamphlet dealing with the manganese industry and deposits of Canada is reprinted from the Annual Report of the Mines Section for 1902, constituting Part S. Vol. XV, N.S., of the Annual Report of the Geological Survey Department.

Pursuant to a policy suggested some years ago and now carried out with your permission, this report is one of a series of similar bulletins intended to give in condensed and popular form, information regarding the mineral resources and possibilities of the country, together with any data regarding similar occurrences in other countries where such would seem to be of use to prospectors and operators in Canada.

I am, sir,
Your obedient servant,

ELFRIC DREW INGALL,
Mining Engineer in Charge.

MINES SECTION,
January 9, 1904.

MANGANESE

Production.

Returns of the production of manganese for 1902 were incomplete and the figures of exports have been given as the closest approximation to the output. The exports were 172 tons valued at $4,062.

The production since 1886 is shown in Table 1 below :

TABLE 1.

MANGANESE.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.	Value per ton.
1886	1,789	$41,499	$23 20
1887	1,245	43,658	35 07
1888	1,801	47,944	26 62
1889	1,455	32,737	22 50
1890	1,328	32,550	24 51
1891	255	6,694	26 25
1892	115	10,250	89 13
1893	213	14,578	68 44
1894	74	4,180	56 49
1895	125	8,464	67 71
1896*	123½	3,975	32 19
1897*	15¼	1,166	76 46
1898	50	1,600	32 00
1899	1,581	20,004	12 65
1900	30	1,800	60 00
1901*	440	4,820	10 95
1902*	172	4,062	23 62

* Exports.

MANGANESE.

Exports.

TABLE 2.

MANGANESE.

EXPORTS OF MANGANESE ORE.

CALENDAR YEAR.	NOVA SCOTIA.		NEW BRUNSWICK.		TOTAL.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
1873	.....	.....	1,031	$20,192	1,031	$20,192
1874	6	$ 12	776	16,961	782	16,973
1875	.....	200	194	5,314	203	5,514
1876	21	723	391	7,316	412	8,039
1877	106	3,699	785	12,210	891	15,909
1878	106	4,889	520	5,971	626	10,860
1879	154	7,420	1,732	20,016	1,886	27,436
1880	79	3,090	2,100	31,707	2,179	34,797
1881	200	18,022	1,504	22,532	1,704	40,554
1882	123	11,520	771	14,227	894	25,747
1883	313	8,635	1,013	16,708	1,326	25,343
1884	134	1,054	469	9,035	603	20,089
1885	77	5,054	1,607	29,595	1,684	34,649
1886	(a) 441	30,854	1,377	27,484	(a)1,818	58,338
1887	578	14,240	837	20,562	1,415	34,802
1888	87	5,759	1,094	16,073	1,181	21,832
1889	59	3,024	1,377	26,326	1,436	29,350
1890	177	2,583	1,729	34,248	1,906	36,831
1891	22	563	233	6,131	255	6,694
1892	84	6,180	59	2,025	143	8,205
1893	123	12,409	10	112	133	12,521
1894	11	720	45	2,400	56	3,120
1895	108	6,348	1/10	3	108 1/10	6,351
1896	123 1/2	3,975	.....	.....	123 1/2	3,975
1897	15 1/4	1,166	.....	.....	15 1/4	1,166
1898	11	325	.....	.....	11	325
1899	67	2,328	3	82	70	2,410
1900	.....	.....	.....	.....	34	1,720
1901	.....	.....	.....	.....	440	4,820
1902	.....	.....	.....	.....	172	4,062

(a) 250 tons from Cornwallis should more correctly be classed under the heading of mineral pigments.

TABLE 3.

MANGANESE.

Imports.

IMPORTS: OXIDE OF MANGANESE.

Fiscal Year.	Pounds.	Value.	Fiscal Year.	Pounds.	Value.
1884	3,989	$ 258	1894	101,863	$4,522
1885	36,778	1,794	1895	64,151	2,781
1886	44,967	1,753	1896	108,590	4,075
1887	59,655	2,933	1897	70,663	2,741
1888	65,014	3,022	1898	130,456	5,047
1889	52,241	2,182	1899	141,356	5,539
1890	67,452	3,192	1900	126,725	4,155
1891	92,087	3,743	1901	272,134	8,176
1892	76,097	3,530	1902 Duty free	476,331	5,360
1893	94,116	3,696			

MANGANESE.

The manganese deposits of Canada were described in a previous annual report of the Mines Section. The present more extended article, bringing our information up to date, and the table of analyses have been compiled by Mr. Theo. Denis from all the available published information.

Although Canada has not so far taken a very prominent place among the manganese producing countries of the world, the reason for this is not due to the lack of deposits of the ores of this metal. By far the greater proportion of the world's production, some 90 per cent of it, is used for the manufacture of ferro-manganese and spiegeleisen. These two alloys of iron and manganese differ from each other only in the proportion of manganese which they contain; up to 30 per cent of manganese the admixture is called spiegeleisen, whereas, when containing greater proportions it is called ferro-manganese, the standard of the latter containing 80 per cent of manganese. These alloys are manufactured to contain all degrees of proportions of the two metals, some spiegeleisen holding as little as two per cent of manganese, whereas high grade ferro-manganese contains as much as 90 per cent. They are used exclusively by steel manufacturers for the production of certain steels of great toughness used for stamp mill dies and shoes, crushing rolls, car-wheels, etc.

Uses manganese.

The extension of manganese production depends greatly on the development of steel manufacture, and as Canada is now making great strides in that direction, its deposits will probably assume before long a much greater importance than heretofore.

Besides the manufacture of steel, manganese ore has several other very important uses, the main one of which is its use as an oxidizing agent in the manufacture of certain chemicals, such as bromine, chlorine manganates and permanganates; it is also one of the elements of the Leclanché cells; it is also used as a decolorizer of glass; as a coloring material in dyeing and in the manufacture of pottery and of paints, etc.

When the manganese ore is used as an oxidizing agent in the manufacture of chemicals, certain requirements of purity and composition are necessary which are not needed in the ore consumed for spiegeleisen and ferro-manganese, and it has therefore a value three to four times greater than that used for the latter purpose. Pyrolusite is the ore of manganese which has the greatest oxidizing power, and as the ore of some of the Canadian deposits contains a large proportion of this mineral, it is specially well adapted to that use. In Canada the ores represented comprise pyrolusite, manganite, psilomelane and wad or bog manganese ore. The principal deposits of the crystalline ores of manganese of the eastern provinces are referred by Dr. Gilpin to a

MANGANESE. horizon low down in the Carboniferous marine limestones, in most cases underlying the lowest beds of gypsum, yet that these ores have a wider distribution is shown by the fact that wad or bog manganese is found in superficial deposits connected with every geological formation known in Nova Scotia and New Brunswick; moreover, occurrences of pyrolusite have been noticed in the quartzites of lower Cambrian age and in granites, also in quartzites and slates of presumably Silurian age, and in Triassic trap rocks.

Origin of manganese deposits.

Dr. Penrose* ascribes the origin of manganese deposits to secondary action and contends that the source of the manganese ores found in the Palæozoic and later sedimentary rocks, is to be traced to the underlying archæan rocks and various igneous rocks of all ages. The fact that the largest manganese deposits in the United States and Canada are in the neighbourhood of such rocks is in itself suggestive; but when it is found that large areas of bog manganese ore occupy basins in the decayed surface of the pre-Palæozoic rocks, and that the river pebbles in areas of these rocks are frequently encrusted with a black coating of oxide of manganese, other facts are encountered which at once suggest a possible pre-Palæozoic source for manganese deposits. Moreover, when it is observed that volcanic breccias are sometimes cemented by manganese, that segregated masses of oxide of manganese are sometimes found in lava, and that the manganese nodules dredged up from the sea bottom are in intimate association with volcanic debris, the possible source of manganese in igneous rocks claims attention. When these two classes of rocks, pre-Palæozoic and igneous, especially the former are examined in their more minute details, and it is found that of the minerals composing them, those containing manganese are among the most common, the probability of their being the source of manganese in the younger rocks becomes established. The different steps of the formation of manganese deposits being as follows:

1. The derivation of the manganese from the decay of the Archæan and other pre-Palæozoic rocks and from the products of igneous action.

2. The solution and transportation of the manganese in the form of soluble organic and inorganic salts of the metal.

3. The precipitation of the manganese as oxide or carbonate.

4. The conversion of the carbonate into oxide.

5. The subsequent decay of the rocks which were deposited with the ore and an accompanying change in the nature of the ore and sometimes in its physical condition. That is to say, that the stages

* Penrose.—Geol. Surv. of Arkansas, 1890.

in the history of the manganese deposits involve first, a decay of the rocks in which manganese is originally present as a constituent; secondly, a series of chemical reactions leading to a redeposition, and thirdly, a decay of the rocks of those newly formed deposits. As Dr. Penrose remarks very appropriately, the various stages in the formation of manganese deposits are similar in many respects to those known usually to have gone on in the formation of certain iron ores, but differ in minor details. Both metals have their origin in the same rocks; they go into solution in the same manner; but in the mode of redeposition, though they sometimes resemble each other, they often differ considerably in the chemical changes which go on in the subsequent alteration of the oxides. Hence manganese is often associated with iron ore deposits and sometimes is comparatively free from such accompaniments. MANGANESE.

In the following description of the known deposits of manganese ore in Canada, the localities will be taken, as far as possible, in their geographical order from east to west, and not in the order of their relative economic importance.

NOVA SCOTIA. Nova Scotia.

This province possesses some of the most important deposits of manganese known in Canada, and as the iron and steel industries in that region are fast developing, these may, in the near future, become important sources of ore.

In Cape Breton, manganese ore is found in the western part of the county of that name. The most important belt of manganese-bearing ore crops out in the district of the head waters of the Salmon river and Loch Lomond. The rocks are of lower Carboniferous age and are met with in a valley between the felsites of the Mira and East Bay hills.

From personal observations and from notes furnished by Mr. Hugh Fletcher, of the Geological Survey of Canada, Mr. Edwin Gilpin describes the general conditions of the occurrence of the ore as follows* :—"The felsites of the Mira hills form a series of bays along which are exposed Carboniferous limestones, conglomerates, shales and grits as they were accumulated, subject to the varying conditions of the winds and currents of the period under consideration. At some points the limestones rest on the felsites; at other localities, grits and shales intervene; elsewhere, the basal conglomerates are covered directly by the millstone grit. The manganese ores were discovered

* Gilpin.—Manganese ores of Nova Scotia.—Trans. R.S.C., Vol. II.

MANGANESE. Nova Scotia.

two years ago in one of these recesses where the felsites were succeeded by shales and grits, and finally by limestones, the latter apparently extending from point to point of the ancient bay. The ores at the western mine are found in irregular bedded layers in a soft arenaceous reddish-coloured shale, which is in some places calcareous and coated with films of manganese oxide. The layers vary hickness up to eighteen inches, and are frequently connected by cross stringers of ore. The shales when weathered present the ore in small nodules, and the disintegration of the former by water probably indicates the source of the beds of gravel manganese ore found lying on them. The ore at the eastern mine occurs as a bed immediately underlying a layer of black manganiferous limestone, with red and greenish shales and coarse grit. The thickness of the ore and limestone varies from two to eight inches, the average thickness of the two being about eight inches. The ore also occurs in this vicinity as lenticular pockets and irregular nests in conglomerate, &c., and sometimes forms the cementing material. The latter mode of occurrence is similar to that shown by the red hæmatites (sometimes highly manganiferous) found at various points in the Lower Carboniferous conglomerates of the island near their junction with older strata."

This deposit was first opened in 1880 by the Hon. E. T. Mosely, of Sydney, and has been worked at two places about three-quarters of a mile apart, near the head of Loch Lomond, eight miles south of the village of Big Pond on East bay. At the most easterly of these, the workings are on a vein about seven inches thick, dipping at an angle of 25° "in red fine sandstone overlying reddish and greenish grit with grains of quartz about the size of wheat, and red marly limestone, red and greenish shale, conglomerate and other rocks, blotched with calc-spar. It is in lenticular layers and also intimately mixed with the limestone, being probably of the same nature and origin as the hæmatite, and forming at times a cover for the pebbles of the conglomerate." *

At the western workings the ore is found in the bedding planes of a bright red argillaceous shale overlaid by calcareous argillaceous shale and limestone, and underlaid by conglomerate. The rocks have here a dip of 32°. Although these steep dips show the result of a general disturbance of the region, yet the rocks have not been as minutely shattered as might be expected. The ore is found both crystalline and massive, a great proportion being pyrolusite; it is very free from iron, remarkably pure, and is well adapted to chemical manufacture. Besides the ore mined from the two workings above mentioned, a large quantity was obtained as drift nodules in the rock beds. These

* Fletcher, Hugh.—Geol. Survey Rep., 82-83-84.

nodules have been washed out of the original decayed rock, and on the outside are earthy, but on breaking, the interior shows the bright black surface of fresh ore.

On Boulardarie island, in the vicinity of Big harbour, a deposit of wad or bog manganese occurs. The deposit is stated to be several feet thick and extensive, but there is a great lack of uniformity in the composition of the ore in different parts of the bed.

There are other occurrences of manganese ores in Cape Breton county. In a limestone quarry at Salem road some pockets of manganese were encountered and mined in 1897. The rocks are of Lower Carboniferous age.

Some samples of wad received at the laboratory of the Geological Survey are said to have been obtained from a deposit situated at the head of Lewis bay.

Hants County.—On the south shore of Minas Basin there is a development of Lower Carboniferous limestone which from the Shubenacadie river extends westward for a distance of about forty miles, as far as the estuary of the Avon. This belt contains a limestone band some 300 feet thick in which are found the most important deposits of manganese of the region, the largest and best known of which are the Tenny Cape mines. It underlies the gypsiferous horizon, and Mr. Fletcher says of it that "next to the gypsum, the most interesting member of this formation is the red basal limestone, along which the manganese ores are found. It is of considerable thickness, concretionary, brecciated and associated in places with red conglomerate and grit." About fifteen miles south of Tenny Cape, near Windsor and at Douglas, the manganiferous limestone reappears. The occurrence of manganese, however, is not confined to the limestone, but it has also been noticed in the Devonian sandstone which is found below the Carboniferous marine limestone, and in places it occurs in large enough quantities to be worked. In this class of deposits which are not in the immediate vicinity of the limestone, the ore occurs in veins, joints or blotches, from one-quarter of an inch to five inches, in Devonian quartzites and shales. The important manganese veins of the district, however, are in the limestone above mentioned, lying at the base of the Carboniferous formation. Work on a comparatively large scale has been performed at Tenny Cape, Walton and Cheverie.

Tenny Cape Mines.—These are the most important workings of the region, and have been worked since 1861. The quantity of ore produced is not very gr at but has been described as the purest and

MANGANESE. Nova Scotia.

most beautifully crystallized pyrolusite found in America. It has of course been chiefly used in the manufacture of chemicals, glass decolorizing, etc. Of the deposit Mr. H. Fletcher writes as follows: "The rock, a twisted, reddish, shaly or brecciated dolomite is sometimes separated by two to four inches of hard red clay from the Devonian sandstone or quartzite which forms the foot-wall or floor of the mine. The ore occurs in veins, strings, nodules and masses. One of the latter is said to have yielded one thousand tons associated with calcite, selenite, barite, and limonite but in some places almost entirely free from foreign matter, It occupies the lines of jointing and bedding, breaks apart the fragments of the breccia and replaces the shale and limestone. The latter dips S. 20°E. at a variable angle beneath a mass of gypsum; it has been worked for about 200 yards on the strike and the whole distance tested is probably less than 500 yards." The workings, as may be inferred from the wavy nature of the deposit, are scattered and irregular; they consist of open cuts, tunnels and shafts, the deepest of which a few years ago was 170 feet

The Parker Mine.—This is situated to the north of the Tenny Cape mine, about three-quarters of a mile from it. The deposit is in a much disturbed limestone, forming apparently an outlier of the Carboniferous basal beds among rocks of Devonian age. In 1881 some thirty tons of excellent pyrolusite were mined, but since then the work has been mostly of a prospecting and development nature.

The Churchill or Walton Mine.—This is on the west bank of Walton river immediately above the bridge, on the shore road some twelve miles north-east of Cheverie. The deposit worked here is also in an outlier of red and gray limestone filling a hollow in red Devonian quartzite and shale. The ore is mainly pyrolusite with some manganite and is associated with calcite crystals and barite. Some large masses of very high grade ore have been mined from this deposit.

In this vicinity, the main development of the manganiferous limestone is encountered a short distance south of the outlier on which is the Walton mine, and these two bear to each other the same relation as the Parker mine deposit does to the Tenny Cape mines. The limestone crosses the Walton river south of Walton, and on both sides of the river extending some distances east and west, it has been subjected to a great deal of prospecting and preliminary work. One of the more important properties is the Stephens mine.

The Stephens Mine.—Of this deposit Mr. Willimott of the Survey, as the results of observations made in 1883, writes as follows: "This mine is situated near the village of Walton, in Hants county, and

consists of an excavation of about thirty feet in depth, in a reddish shaly limestone, striking E. and W. with a southerly dip. Pockets and irregular veins of manganite and pyrolusite can be traced along the strike for about 400 yards.

Nothing beyond the preliminary prospecting work, scarcely sufficient to develop this promising mine, had been done at the time of my visit. Mr. Stephens informed me that about ten tons of fair grade ore had been taken out during the progress of their investigations. The limestone belt is perhaps continuous to Hibernia where a quantity of ore was found in reddish calcareous grit interstratified with concretionary limestone."

Sturgis Mine.—At this place which is about two miles west of Walton, manganese ore occurs in somewhat large quantities, as stringers, veins and films, or impregnations and stains in large masses of both the limestone and of the underlying flinty sandstone, in both of which shafts have been sunk and tunnels driven.

Tomlinson Mine.—This is situated west of the above mine and consists of openings made in the reddish and grey quartzite which underlies the limestone. These openings show masses of pyrolusite and hæmatite, sometimes mixed, sometimes separated.

Lantz Mine.—Several shallow pits have been opened in limestone, and from these workings some fine specimens of pyrolusite were obtained.

The Cheverie Mine.—This is situated near the village of Cheverie and the deposit here worked underlies the gypsum of the Cheverie quarries. The ore, a mixture of pyrolusite and manganite, occurs in a reddish and grey concretionary limestone, and is associated with white calcite in a network of small veins, from an eighth of an inch to three or four inches in thickness. Frequently the calcite associated with the manganese is in long crystals standing at right angles to the wall of the veins and forming a comb structure on both sides of the manganese.

According to observations made by Mr. H. Fletcher, at Cheverie, the ore is found near the top of the manganiferous band of limestone, at Walton it is found at the base of it near the contact with the underlying quartzite, and at Tenny Cape the best development of ore is met with at some thirty-seven feet from the bottom.

Minasville or Moose Brook Mines.—This mine is situated some four miles northeast of Tenny Cape. The occurrence of manganese ore here is not in the limestone, but in the underlying Devonian quartzites,

MANGANESE. Nova Scotia.

where it is found in joints, veins and blotches, varying from a quarter of an inch to five inches in thickness. A certain quantity of ore has been shipped from these workings.

The same geological conditions are observed at Bear brook and at a deposit east of Noel river, where some preliminary work yielded small quantities of pyrolusite.

In Hants county other occurrences of crystalline manganese ores, more or less important have been noticed at Douglas, Rawdon, Goshen and other places. Bog manganese occurs near Goshen, south of Cheverie, at the head of Bass creek.

Colchester County, East Onslow.—At this place is the most important deposit of manganese now known in Colchester county. The ore occurs in the joints and bedding planes of old Devonian quartzite. In some places the ore which consists mainly of pyrolusite, is a foot thick; some manganite and psilomelane are also encountered. Operations were begun on this deposit in 1886 or 1887 and have since been carried on intermittently. The principal workings consist of a shaft fifty-five feet deep, and a large irregular cut.

Valley, Manganese Mines.—At Manganese Mines near Valley, a quantity of black oxide of manganese is found in irregular veins cutting a reddish, slaty rock, which underlies the Carboniferous limestone.

Farham's Mill brook.—From the appearance of the occurrence of manganese at this place the deposit is a contact deposit between grey, rusty, concretionary, massive Carboniferous limestone and Devonian rocks. The ore occurs mostly in pockets in the limestone which also contains disseminated hæmatite, giving the rock a mottled weathering appearance.

Other occurrences of manganese ores have been noted on both shores of Minas basin in Colchester county. At Black Rock mine, near Clifton, at the mouth of the Shubenacadie river some work was done on a deposit in limestone. The ore which was of a ferruginous and magnesian nature was found in small quantities.

On the north shore of Minas basin at Lower Economy several barrels of fine crystalline pyrolusite were obtained in 1891. The occurrence is similar to those of East Onslow.

Besides the above occurrence, manganese is also found in large quantities associated with the important deposits of iron ores of Londonderry iron mines. The iron ore is found as veins of brown hæmatite

accompanied by ochre, ankerite and sideroplesite. In places secondary changes have enriched the iron ore with manganese peroxide to the extent of fourteen per cent of its total constituents. MANGANESE. Nova Scotia.

Other localities in Nova Scotia where occurrences of manganese ores have been observed, are as follows :—

In Cumberland county, Minudie, some small quantities of soft fine-grained pyrolusite were obtained from the Lower Carboniferous limestone. At Amherst (Cumberland) some manganese ore occurs in the same formation.

At Springhill (Cumberland) and Parrsboro', wad is met with in superficial deposits.

At New Ross, in Lunenburg county, a few shipments of ore are said to have been made from the college grant. The ore appears to be a mixture of psilomelane and manganite occurring in veins sometimes three feet in thickness. Wad is reported to occur at La Have and Chester, Lunenburg.

In Pictou county deposits of manganese ore are met with in connection with the iron ore deposits at Bridgeville and at Springhill, where boulders and concretions of psilomelane, manganite and wad are found.

In Antigonish county, near the head of the Ohio settlement, large pieces of pyrolusite were found in the drift on a hill, and in the same county occurrences of wad have been noticed near Afton; in Pomquet river; in Sutherland's brook and on a hill west of Piedmond station.

In King's county, near Wolfville, pyrolusite is found in small masses and stringers, in slates of Devonian age.

In Halifax county, at Musquodoboit and Ship Harbour, pyrolusite occurs as veinlets in granite, and at Jeddore, wad is found in the superficial deposits.

NEW BRUNSWICK. New Brunswick.

The geological characters of the manganese deposits in New Brunswick resemble those of Nova Scotia. They are found in rocks of pre-Carboniferous age as well as in Lower Carboniferous measures, besides the superficial deposits of wad. The most important deposits, from an economic standpoint, are, however, those found in the Lower Carboniferous limestone.

Gloucester County.—In the vicinity of Tête à Gauche Falls, some eight miles from Bathurst, a deposit of pyrolusite occurs, in the red

MANGANESE. New Brunswick.

slates of the district which are probably of Cambrian age. The ore is found in numerous small veins, some of which are said to be as wide as eight inches; and detached masses of it are often found in the superficial deposits in the neighbouring fields. This occurrence was the first to attract attention to the manganese ores of the province; it was worked a number of years ago, and a certain quantity of ore is said to have been shipped from this place. As a result of personal examination, Dr. Bailey is of opinion that the district is worthy of closer examination than it has yet received. Unfortunately, the conditions are not very favourable to easy prospecting, as the district is flat and deeply covered with clayey soil.*

King's County.—In this county are the deposits of Markhamville, which are the most important ones of the province. These deposits were examined by Dr. Penrose in 1890, and as a result of his visit he describes them as follows:

† "The Markhamville mine is situated at the village of Markhamville near the head of Hammond river in Kings county about forty miles north-east of St. John, about fifteen miles north of the shore of the Bay of Fundy, and about eight miles south of Sussex on the Intercolonial railway. The existence of manganese was noted at the head waters of the Hammond river many years ago by Mr. Geo. F. Matthew, of the Geological Survey of Canada, but the property was first opened about 1864 under the management of Major A. Markham. Major Markham was the first to attempt to develop in a systematic manner the manganese deposits of this province, and it is due to his energy and perseverance that the ores have been introduced into the market

"The ore occurs either as crystalline pyrolusite and manganite, or in a compact, massive, nodular or bedded form, sometimes containing psilomelane.

"The ore-bearing limestone is generally of a gray colour, but at times is pink or buff, and is associated with shaly strata. It contains veins of crystalline calcite in which masses of pyrolusite are frequently found, but the principal ore deposits are lenticular bodies interstratified with the limestone. These ores occur as irregular pockets or as flat layers more or less continuous for considerable distances, and becoming thin and thick at intervals. In some places such deposits widen out into pockets from which several hundred tons of ore have been taken and in one opening 3,000 tons are said to have been mined.

* Annual Report Geol. Surv. of Can., Vol. X. (N.S.), 1897. Part M.

† The Manganese deposits of U. S. and Canada, by Dr. Penrose. Geol. Survey of Arkansas, vol. I., 1890.

Though in places the pockets do not always adhere strictly to the bedding of the rock, yet in a general way they follow it. Sometimes veins and pockets cut directly across the bedding, but these are generally smaller than the others and are probably due to a secondary chemical action by which they have been derived from the bedded ores.

"The surface of the limestone has often been decomposed, and a red residual clay, frequently mixed with surface gravel, has collected in considerable quantities. The ore that was originally in the part of the limestone which has decayed, is now found buried in the clay; and therefore deposits of ore-bearing clay or gravel, overlying the partly decomposed surface of the limestone, are of frequent occurrence. Such deposits are rarely more than from eight to twenty feet in thickness, but the ore in them is cheaply worked and they have supplied a large part of the output of the Markhamville mine. Frequently the decomposition of the limestone has spread downward more rapidly along the outcrop of a body of ore than elsewhere, causing somewhat abrupt hollows filled with residual clay and manganese ore and containing in the bottom the outcrop of the ore in situ in the rock.

"Not only has decomposition taken place on the surface but it has also gone on to a considerable extent underground frequently causing subterranean cavities and passages. When these have intersected bodies of manganese the floors are covered with loose fragments of ore, brought there in the same way as that in the residual clay on the surface. Kidney-shaped masses of glossy, black limonite are frequently found with the cave deposits, and these also have doubtless come from the limestone.

"Though a large amount of manganese has been taken from the surface clay beds and the caves, yet the deposits of ore in the limestone have also been extensively worked, and in many places the rock is honeycombed with a network of shafts and drifts, following the erratic courses of the ore bodies in all their intricacies.

"The thickness of the limestone varies considerably: in one of the pits a depth of twelve feet was found, and a diamond drill boring in another part of the property showed a thickness of fifty-five feet. Probably a greater thickness will be found elsewhere. The bed is much disturbed and is folded into small anticlines and synclines, but at Markhamville it has a general dip to the northwest and a strike of northeast and southwest. In many places it contains fossils, and sometimes the carbonate of lime of these has been partly replaced by manganese, which has subsequently been oxidized and now exists as a black, more or less calcareous mass.

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"The Hammond river rises near Markhamville and flows south-west, parallel to the coast of the Bay of Fundy, until it finally turns south and empties into the bay about eight miles south east of St. John. In the region of Markhamville, and for some miles down the river, the Lower Carboniferous limestone occupies the centre of the valley; but it is only locally that manganese occurs in it, and only at the Markhamville mine that it has yet been found in large quantities.

"The limestone area is bordered on the south by a range of hills which forms the southern barrier of the Hammond river valley. According to information kindly furnished by Mr. G. F. Matthew, of the Geological Survey of Canada, these hills are composed largely of the underlying pre-Cambrian rocks, and the Carboniferous rocks dip away from them. To the north of the river the limestone is cut off in many places by an abrupt escarpment of Carboniferous conglomerate, which according to the same authority, probably belongs above the manganese-bearing limestone.

"The ore from this mine is mostly used for chemical purposes. It is prepared for market by crushing, washing and sizing with screens. Certain quantities of the lower grades, however, are shipped without previous preparation, under the name of "furnace ore" and are used in the manufacture of spiegeleisen and ferro-manganese."

The importance of the Markhamville mines may be realized by the fact that between 1868 and 1894, the total exports of manganese ore from New Brunswick amounted to over 23,000 tons representing a value of nearly $410,000, almost the whole of which, was derived from the Markhamville deposits. (Dr. Bailey, Mineral Resources of New Brunswick.)

King's County, The Glebe mine.—The deposit of the Glebe Mine is situated some three miles N.N.E. of the Markamville vein, and seven miles from Sussex station on the Intercolonial Railway.

Dr. Penrose in his bulletin on the manganese ores of America describes this occurrence as follows:—"The ore is found in a limestone resembling that at Markhamville, though it is much less disturbed than at that place and dips gently to the west. The manganese ore occurs in the limestone in nodules and thin layers, frequently associated with calcite and following the general direction of the stratification. Several shafts and tunnels have been made, the deepest shaft being 85 feet."

King's County, Jordan Mountain.—This deposit is situated on the south-eastern side of Jordan mountain, about seven miles from Sussex

station on the Intercolonial Railway. According to Dr. Bailey, the geological relations here are similar to those of Markhamville; the ore is found in strata of Lower Carboniferous age near their contact with older metamorphic rocks. But instead of occurring as in the last-named locality, in limestone, it is found in connection with shales and shaly conglomerate, the brecciated character of which is in contrast with the rocks at Markhamville. Work was begun on this deposit in 1882 and some good ore is said to have been extracted from an open cut. The ore is a mixture of pyrolusite and manganite occurring in lenticular interbedded masses. There are also small veins and stringers of manganese oxide penetrating the surrounding rocks.

King's County, Hillsdale.—Some fine surface indications of manganese ore are said to have been observed at Hillsdale about five miles southeast from Elgin corner. No particulars of this deposit are available.

St. John County, Quaco Head mine.—This is situated on the north shore of the Bay of Fundy on a promontory which forms the southern boundary of Quaco Harbour. The mine is about one mile south of the village of St. Martins. The following description of the deposit is taken from the bulletin by Dr. Penrose who examined it in 1890 when it was being worked by the Brunswick Manganese Company. "The manganese is sometimes crystalline representing pyrolusite and possibly also manganite, while at other times it is hard and massive, possibly representing psilomelane, and still again it is in porous honeycombed form. These ores are found in Lower Carboniferous shales and limestones, associated with a large conglomerate bed.

"The rocks are greatly disturbed and have been much shattered and broken by igneous intrusions. They now stand at steep angles sometimes almost vertically, exposing in different parts of the headland areas of limestone, shale, and coarse conglomerate. Masses of igneous material protrude into these beds at different points and on either side of the headland are beds of Triassic sandstone and fine conglomerate lying unconformably on the upturned edges of the older rocks.

"The manganese occurs as nodules and irregular discontinuous veins, in both the shale and the limestone, though the larger quantities are in the former. The nodules vary from a fraction of an inch to several inches in diameter, and the thickness of the veins is equally variable. The disturbed character of the rocks renders it somewhat difficult to determine the thickness of the main ore-bearing bed but it is probably not over thirty feet though smaller quanties of manganese are found in the rocks on either side. The ore is scattered through this thickness in very variable quantities. . . . . .

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"The igneous rock is a hard light gray, close-grained material of a texture somewhat like trap. The limestone is like that of Markhamville, though it is much reddened at the contact with the igneous rock. The conglomerate bed is composed of coarse pebbles of metamorphic rocks. It dips steeply to the south and forms a bold bluff on which the lighthouse of Quaco Head is situated. The sandstones and conglomerates at each end of the section are of a brick red colour and vary from coarse sandstone to a fine conglomerate, with pebbles from a quarter of an inch to one inch in diameter, both sand and pebbles being composed of white quartz stained by a ferruginous cement. Sometimes these beds contain small irregular seams or nodules of manganese ore, which, however, are in very limited quantity, and have doubtless been derived during the deposition of the beds, from the erosion of the Lower Carboniferous rocks.

"The ore-bearing rocks can be traced back on the promontory at intervals for almost a mile, to a place where an opening has been made on the farm of Mr. Molaskey. On the north side of the head, small scattered nodules of manganese ore are found in the gravel drift that lines that part of Quaco Harbour, and extends inland over the Lower Carboniferous rocks. They have doubtless been derived from the latter rocks during deposition of the gravel, in the same way that the red sandstone just mentioned obtained its manganese contents at an earlier date."

Subsequent to Dr. Penrose's visit the Brunswick Manganese Company erected a well-equipped mill, consisting mainly of a crusher, rolls, screens, two jigs, etc. The mine is exceptionally well situated for shipping by water. Operations have, however, been discontinued for several years.

Albert County, Shepody mines.—Shepody mountain is one of the highest eminences in southern New Brunswick. The lower part of this mountain is composed of chloritic hydro-mica schists, and the upper part consist of Lower Carboniferous strata; at the contact between these two sets of rocks are found the manganese occurrences.

Dr. Ells in his report for 1885* writes as follows:—"Shepody mountain, 1,050 feet high, is a rugged peak which forms a prominent landmark for many miles in all directions, and was one of the signal stations for the Admiralty survey of the Bay of Fundy. It is composed largely of red conglomerates, which are well exposed on the east flank in Robertson's brook and its branches. A deposit of reddish

* Geol. Surv., Can., Report of Progress, 1885.

impure limestone has been opened up at this place for a marble quarry, but the rock was found to be too much shattered to be of great value. The limestone contains a small quantity of manganese. The rocks of the mountain rest upon a small outlier of the talco-chloritic schists which show on the road to the north, leading to Curryville, and are flanked on the east by the gray sandstones of the millstone grit. On the north-west side a large deposit of manganese was worked for some years, a tunnel being driven into the mountain along the contact with the underlying schists for nearly 1,000 feet. The ore, which consisted of pyrolusite and psilomelane occurred at the base of the conglomerate in irregular pockets."

The Shepody mountain mines were first opened in 1860, and it is said that 500 tons of ore was extracted. This were a compact black oxide, less crystallized than the ores of Markhamville, but of high grade. It was found both in veins and in interbedded masses.

Albert County, Elgin.—Gowland Mountain.—On the north-east side of the mountain some exploratory work revealed occurrences of pyrolusite and psilomelane in a very broken and decomposed granite of pre-Cambrian age.

In the same county, on the east side of Salisbury bay, a small deposit of manganese occurs near a contact of Lower Carboniferous and Triassic sandstones. This deposit was worked many years ago but shortly abandoned.

Albert County, Dawson Settlement.—At this place occurs a very important deposit of wad or bog manganese. Dr. Bailey, who visited the deposit in 1899, gives the following description, which is the latest and fullest available :—

"This very remarkable deposit is located about five miles and a half from the town of Hillsborough, on the slope of a hill inclining north-easterly at a low angle towards a small brook, flowing thence to the Petitcodiac river, and whose opposite slope is occupied by the settlement above named. The upper part of the first ridge is wooded, but between the edge of the latter and the brook the ground is cleared and upon removal of a thin coating of vegetable matter, usually not more than two inches in depth, is found to be everywhere covered with a very fine black powdery deposit consisting essentially of manganese oxide.

"The property, as leased, embraces an area of about 150 acres, and upon about eighteen or twenty acres, or as far as searched for, the ore has been found, the deposit varying in depth from a few inches to

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thirty feet. In a survey recently made by a Crown land surveyor, seventy-three borings were made, in squares of 100 feet, over a space of seventeen acres, showing an average depth of six feet seven and three-quarter inches, equal to 1,900 pounds to the cubic yard. There is accordingly already in sight and available for use :—

	Tons.
In situ on hillside, 17 acres	173,176
In drying-house and sheds	400
Total	173,576

According to the statements of the manager of the property Mr. R. P. Hoyt, to whom I am indebted for assistance and valuable information, the iron rods used in the above borings, in many of the deepest places, failed to go down over twenty-five or thirty feet, and then struck what was apparently hard manganese ore, so that the above results indicate the minimum quantity. These ores are, in comparison with those of Markhamville, low grade ores and would be of little or no value for the uses to which the latter are chiefly put, nor in their natural condition would they have commercial value of any kind. It is, however, proposed to subject them to a bricquetting process whereby the pulverulent and absorbent mass shall be rendered solid, non-absorbent, and capable of easy handling, in which condition it may be advantageously used in the manufacture of spiegeleisen and ferro-manganese. For this purpose an extensive plant embracing drying furnaces compressors, bricquetting machines, etc., has been erected close by the manganese deposits, and also near to the track of a branch railway one mile and a half in length, built by the company, and connecting with the Harvey and Salisbury Railway at a point eleven miles from Salisbury, whence, over the Intercolonial Railway the product may be readily shipped to all Canadian and United States points. The shipping point by sea is five miles and a half by rail from the mine to Hillsborough, with direct landing at wharf for vessels of 800 to 1,000 tons capacity." This company, "The Mineral Products Company of New York," sent the bricquettes to Bridgeville, Nova Scotia, where the smelting plant of "The Picture Charcoal Iron Company" had been secured for the manufacture of ferro-manganese. For some unknown reason, after a period of apparently successful operations this company have discontinued work.

Besides this deposit of wad, other deposits have been noticed at different places, among which are Queensbury, York county; north branch of S. W. Miramichi; in gravelly bank near government house

at Fredericton; near Harvey, Albert county; Bull Moose Hill, Kings county; Moore's Mills, Charlotte county and other places.

As to the probable origin and mode of formation of the deposits of wad or bog manganese, Dr. Chalmers* assigns it to the action of springs.

In the case of the Dawson Settlement deposit, the bed of wad lies in a valley at the northern base of a hill, and springs are trickling down the hillside; doubtless the process of formation of bog manganese is still going on. Dr. Bailey on the same subject writes as follows:

"An interesting question in connection with these deposits is that of their probable origin. Upon this point the locality throws very little light, there being absolutely no exposures of rocks anywhere in the vicinity or any visible source from which the manganese may have come. The nearest rocks are indeed those of the millstone grit, though these are doubtless underlain, as at Hillsborough and about the Albert mines by Lower Carboniferous rocks, including limestones. None of these however, are markedly manganiferous. It is also a little singular that the deposit should have such a decided slope instead of being, as usual with bog ores, nearly horizontal. Finally, the abruptness with which the deposits end along the line of the brook referred to above, towards which it inclines while no such material is to be found on the opposite slope, is also remarkable, and seems to suggest that the ores are the result of deposition from springs originating on the one slope but wanting on the other, while the brook has carried off the excess of the solvent water. In support of this view it may be observed that the hillside on which the ore beds rest, is remarkable for the number of springs which issue from its surface, in the waters of which both iron and manganese may be readily detected."

QUEBEC.

In this province the only occurrences of crystalline manganese ore are those of the Magdalen islands in the Gulf of St. Lawrence. From an examination of these islands Mr. Jas. Richardson in the report of the Geological Survey for 1879-80 writes as follows: "Immediately under Demoiselle hill, on Amherst island, numerous blocks charged with peroxide of manganese or pyrolusite, occur among the debris of the fallen cliffs. They are in pieces varying from one pound to ten or fifteen pounds in weight. There can be little doubt that they are derived from a deposit more or less regular in the hill side, but which

* Annnal Report Geol. Surv. Can., Vol. VII, (N.S.), 1894, Part M.

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is now completely concealed by the fallen debris. At a place bearing nearly due west from Cap aux Meules, at the distance of about a mile, and close to the English Mission church, similar pieces to those above described are very frequently picked up." These deposits have lately attracted some attention, and in 1903 were purchased by a syndicate which intend working them.

Wad or bog manganese has been observed at a great number of points in this province but the quality is poor as a rule, and of small commercial value. Of these deposits one of the most considerable is in the township of Stanstead, lot 9, range X; This deposit is stated to cover an area of about twenty acres with a maximum thickness of about twelve inches. Some of this ore after undergoing a washing to free it from the sand, gave 37 per cent of peroxide.

Another deposit of several hundred square yards in extent with a maximum thickness of six inches was observed in the township of Bolton, lot 20, range XII.

Mr. A. P. Low, mentions the occurrence of wad on the St. Louis road some four miles and a half from Quebec. The deposit here is about sixty yards by five with a maximum observed thickness of twelve inches.

The following other occurrences were compiled from the reports of the Geological Survey. The majority are of limited extent.

On the road from Lambton to St. Francis, Beauce county, near the eastern boundary of the township of Tring; on the west side of the Chaudiere river, opposite the mouth of the Famin river; in the seignory of the Mesy; in the seignory of Ste. Anne de la Pocatiere in rear of the church; in Cleveland township, county of Richmond, on lot 16, range XIII; in St. Sylvester lot 9, range St. Charles; in Gaspe seignory, half a mile west of St. Apollinaire church.

Ungava Territory

UNGAVA TERRITORY.

In his report on the east coast of Hudson bay, Dr. Bell mentions the occurrence of very important deposits of spathic iron ore in the Nastapoca chain of islands. These ores are in places very rich in carbonate of manganese; an average specimen from Flint island yielded 25·44 per cent metallic iron and over 24 per cent of carbonate of manganese. These deposits are very accessible and may some day be worked profitably. The high contents of manganese in these ores would render them valuable in the manufacture of spiegeleisen.

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ONTARIO. MANGANESE.

Ontario.

There are very few occurrences of ores of manganese in this province, and none of these has been worked. One of the first discoveries is that of Bachewanung bay on Lake Superior, which is described as follows in the "Geology of Canada 1863."

"At Bachewanung bay, near the southwest end of the Upper Canada Mining Company's location, and not far from the shore is a large vein of manganese ore, running north and south, and from fifty to sixty feet wide. It is described as presenting the aspect of a succession of small knobs, in which, mixed with a reddish trappean rock, are numerous strings of the ore, associated with quartz and calc-spar, and occasionally with octahedral crystals of fluor. The ore, which is massive with small geodes of crystals, is described by Prof. Hadley as manganite or hydrous sesquioxide of manganese, which for manufacturing purposes is inferior to the peroxide. A specimen was found by assay to be equal to sixty per cent of peroxide of manganese."

In the Rainy lake district manganese has been discovered associated with the iron ore deposits to the north of Gunflint lake; an occurrence is described as follows by Mr. Conmee in the second report of the Ontario Bureau of Mines; "This range (iron ore) is near Sand lake, four miles from the Port Arthur, Duluth, and Western railway. The deposit has been found to be a large one. A pit has been sunk about 15 feet, and as far as the pit has shown up the vein, it seems to be very much decomposed. The ore assayed 65½ per cent. of iron and carried also a good percentage of manganese. The manganese appears to be dispersed among the iron, but it also occurs in pockets; they have taken out small quantities of manganese almost pure."

Wad or bog manganese occurs at several places in Ontario but has not attracted any attention, so that very little is known about these occurrences. An extensive deposit is said to occur in Hastings county, Madoc tp., lot 4, range V.

NORTH-WEST TERRITORIES.

North-west Territories.

In Assiniboia a deposit of manganese ore is reported to occur on the north bank of the north fork of Willow creek. Tp. 5, R. 1, west of 4th Mer.

Mr. Pearce gives the following description of the deposit: "The manganese is found in pockets in a honeycombed formation four or five feet thick, composed of clay and sand with no sulphur or lime. Taking the deposit as a whole, manganese is estimated to run 5 per cent."